

Does Foreign Direct Investment Increase the Productivity of Domestic Firms?

In Search of Spillovers through Backward Linkages

Beata K. Smarzynska



Abstract

Many countries compete against one another in attracting foreign investors by offering ever more generous incentive packages and justifying their actions with the productivity gains that are expected to accrue to domestic producers from knowledge externalities generated by foreign affiliates. Despite this being hugely important to public policy choices, there is little conclusive evidence indicating that domestic firms benefit from foreign presence in their sector. It is possible, though, that researchers have been looking for foreign direct investment (FDI) spillovers in the wrong place. Multinationals have an incentive to prevent information leakage that would enhance the performance of their local competitors in the same industry but at the same time may want to transfer knowledge to their local suppliers in other sectors. Spillovers from FDI may be, therefore, more likely to take place through backward linkages—that is, contacts between domestic suppliers of intermediate inputs and their multinational clients—and thus would not have been captured by the earlier literature.

This paper focuses on the understudied issue of FDI spillovers through backward linkages and goes beyond existing studies by shedding some light on factors driving this phenomenon. It also improves over existing literature by addressing several econometric problems that may have biased the results of earlier research. Based

on a firm-level panel data set from Lithuania, the estimation results are consistent with the existence of productivity spillovers. They suggest that a 10 percent increase in the foreign presence in downstream sectors is associated with 0.38 percent rise in output of each domestic firm in the supplying industry. The data indicate that these spillovers are not restricted geographically, since local firms seem to benefit from the operation of downstream foreign affiliates on their own, as well as in other regions. The results further show that greater productivity benefits are associated with domestic-market, rather than export-oriented, foreign affiliates. But no difference is detected between the effects of fully-owned foreign firms and those with joint domestic and foreign ownership.

The findings of a positive correlation between productivity growth of domestic firms and the increase in multinational presence in downstream sectors should not, however, be interpreted as a call for subsidizing FDI. These results are consistent with the existence of knowledge spillovers from foreign affiliates to their local suppliers, but they may also be a result of increased competition in upstream sectors. While the former case would call for offering FDI incentive packages, it would not be the optimal policy in the latter. Certainly more research is needed to disentangle these two effects.

This paper—a product of Trade, Development Research Group—is part of a larger effort in the group to study the contribution of trade and foreign direct investment to technology transfer. Copies of the paper are available free from the World Bank, 1818 H Street NW, Washington, DC 20433. Please contact Paulina Flewitt, room MC3-333, telephone 202-473-2724, fax 202-522-1159, email address pflewitt@worldbank.org. Policy Research Working Papers are also posted on the Web at <http://econ.worldbank.org>. The author may be contacted at bsmarzynska@worldbank.org. October 2002. (29 pages)

The Policy Research Working Paper Series disseminates the findings of work in progress to encourage the exchange of ideas about development issues. An objective of the series is to get the findings out quickly, even if the presentations are less than fully polished. The papers carry the names of the authors and should be cited accordingly. The findings, interpretations, and conclusions expressed in this paper are entirely those of the authors. They do not necessarily represent the view of the World Bank, its Executive Directors, or the countries they represent.

Does Foreign Direct Investment Increase the Productivity of Domestic Firms? In Search of Spillovers through Backward Linkages

Beata K. Smarzynska

Keywords: spillovers, foreign direct investment, technology transfer

JEL classification: F23

* The World Bank, 1818 H St, NW, MSN MC3-303, Washington DC, 20433. Tel. (202) 458-8485. Email: bsmarzynska@worldbank.org. I wish to thank Enrique Aldaz-Carroll, Andrew Bernard, Simon Evenett, Holger Görg, Mary Hallward-Driemeier, Pravin Krishna, Hiau Looi Kee, Maryla Maliszewska, Jacques Morisset, Marcelo Olarreaga, Maurice Schiff, Matt Slaughter, Mariana Spatareanu and the participants of the Tuck International Trade Summer Camp for valuable comments and suggestions. The financial support received from the Foreign Investment Advisory Service (FIAS) – a joint facility of the IFC and the World Bank – is gratefully acknowledged. This paper is part of a larger FIAS effort to improve the understanding of spillovers from multinational corporations to local firms.

Introduction

Following the advice of multilateral development agencies, policymakers in many developing and transition economies place attracting foreign direct investment (FDI) high on their agenda, expecting FDI inflows to bring new technologies, know-how and thus contribute to increasing productivity and competitiveness of domestic industries. Many countries go beyond national treatment of multinationals by offering foreign companies, through subsidies and tax holidays, more favorable conditions than those granted to domestic firms.¹ As the economic rationale for this special treatment, policy makers cite positive externalities generated by FDI through productivity spillovers to domestic firms.

The only trouble is that there is no proof that positive productivity externalities generated by foreign presence actually exist. As Dani Rodrik (1999) remarked, “today’s policy literature is filled with extravagant claims about positive spillovers from FDI but the evidence is sobering.” And indeed the difficulties associated with disentangling different effects at play and data limitations have prevented researchers from providing conclusive evidence of positive externalities resulting from FDI. While recent firm-level studies have overcome many of the difficulties faced by the earlier literature, the message emerging from them is not very optimistic.

The existing literature on this subject is of three kinds. First, there are case studies including descriptions pertaining to particular FDI projects or specific countries, which however rarely offer quantitative information and are not easily generalized (see for instance, Rhee and Belot, 1989; Moran 2001). Then there is a plethora of industry level studies, most of which show a positive correlation between foreign presence and sectoral productivity.² Their downside is the difficulty in establishing the direction of the causality. It is possible that this positive association is caused by the fact that multinationals tend to locate in high productivity industries rather than by genuine productivity spillovers. It may also be a result of FDI inflows forcing less productive domestic firms to exit and/or multinationals increasing their share of host country

¹ For instance, in the late 1980s, the state of Kentucky offered Toyota an incentive package worth (in present value) 125-147 million dollars for a plant expected to employ 3,000 workers. In 1991, Motorola was paid 50.75 million pounds to locate a mobile-phone factory employing 3,000 people in Scotland (Haskel et al., 2001, p. 1). FDI incentives are also offered by developing and transition economies. As an illustration may serve the fact that foreign firms in Hungary received 92.6 percent of all tax concessions provided in the country in 2000 (Csaki, 2001, p. 16).

² See, for example, the pioneering work by Caves (1974) focusing on Australia, Blomström and Persson’s (1983) and Blomström and Wolff’s (1994) papers on Mexico and the summary of studies on Mexican data by Blomström (1989).

market, both of which would raise the average productivity in the industry. Finally, there is research based on firm-level panel data, which examines whether productivity of domestic firms is correlated with the extent of foreign presence in their sector or region. However, most of these studies, such as for instance, careful analyses done by Haddad and Harrison (1993) on Morocco, Aitken and Harrison (1999) on Venezuela and Djankov and Hoekman (2000) on the Czech Republic cast doubt on the existence of spillovers from FDI in developing countries. They either fail to find a significant effect or produce the evidence of negative horizontal spillovers, i.e., the effect the presence of multinational corporations has on domestic firms in the same sector. The picture is more optimistic in the case of industrialized countries as a recent paper by Haskel, Pereira and Slaughter (2002) gives convincing evidence of positive FDI spillovers taking place in the UK.³

It is possible, though, that researchers have been looking for FDI spillovers in the wrong place. Since multinationals have an incentive to prevent information leakage that would enhance the performance of their local competitors, but at the same time might want to transfer knowledge to their local suppliers, spillovers from FDI are more likely to be vertical rather than horizontal in nature. In other words, spillovers are most likely to take place through backward linkages, that is contacts between domestic suppliers of intermediate inputs and their multinational clients, and thus they would not have been captured by the earlier studies.⁴

As Blomström et al. (2000) point out, however, there are hardly any empirical studies analyzing explicitly the relationship between linkages and spillovers. The notable exceptions are two recent papers by Blalock (2001) and Schoors and van der Tol (2001), which provide evidence of positive FDI spillovers through backward linkages.⁵ Moreover, despite the keen interest of policy makers in the subject, little is known about factors driving vertical spillovers. This study takes the first step towards filling this gap in the literature.

The purpose of this study is twofold. First, we examine whether the productivity of domestic firms is correlated with the presence of multinationals in downstream sectors (i.e., their potential customers). Detecting such an effect would be consistent with the existence of broadly

³ For a survey of the literature on horizontal spillovers from FDI see Görg and Strobl (2001).

⁴ For a theoretical justification of spillovers through backward linkages see Rodriguez-Clare (1996), Markusen and Venables (1999) and Saggi (2002). For case studies see Moran (2001).

⁵ Kugler (2000) also finds inter-sectoral technology spillovers from FDI in Colombia. However, he does not distinguish between different channels through which such spillovers may be occurring (e.g., backward versus forward linkages).

defined spillovers through backward linkages. We improve over the existing literature by taking into account econometric problems that may have biased the results of earlier work. Namely, we employ the semiparametric estimation method suggested by Olley and Pakes (1996) to account for endogeneity of input demand. Moreover, we correct standard errors to take into account the fact that the measures of potential spillovers are industry specific while the observations in the data set are at the firm level. As Moulton (1990) pointed out, failing to make such a correction will lead to serious downward bias in the estimated errors thus resulting in spurious finding of statistical significance for the aggregate variable of interest.

Second, we go beyond the existing literature by shedding some light on determinants of spillovers. We examine whether potential benefits stemming from vertical linkages are related to export-orientation of multinationals in downstream sectors and the extent of foreign ownership in affiliates. Based on case studies and investor surveys, these factors have often been conjectured to influence the extent and benefits of backward linkages, but to the best of our knowledge, their impact has not been systematically examined.⁶

Our analysis is based on the data from the annual enterprise survey conducted by the Lithuanian Statistical Office. The survey coverage is extensive, as firms accounting for about 85 percent of output in each sector are included. The data constitute an unbalanced panel spanning over the period 1996-2000. Focusing on a transition economy, such as Lithuania, seems very suitable for this project as the endowment of skilled labor enjoyed by transition countries makes them a particularly likely place where productivity spillovers could manifest themselves.⁷

Our results can be summarized as follows. We find empirical evidence consistent with the existence of positive spillovers from FDI taking place through backward linkages but no indication of spillovers occurring through horizontal channels. In other words, firm productivity is positively correlated with the extent of potential contacts with multinational customers but not with the presence of multinationals in the same industry. The data also indicate that these correlations are not local in nature, that is, they are not restricted exclusively to foreign firms operating in the same region of the country. The magnitude of the effect is economically meaningful as a ten percent increase in the foreign presence in downstream sectors is associated

⁶ See UNCTC (2001, chapter 4) for a comprehensive review of this topic.

⁷ For instance, during 1990-2000 the number of scientists and engineers in R&D activities per million people was equal to 2,031 in Lithuania, as compared to 2,139 in Korea, 711 in Argentina, 168 in Brazil and 154 in Malaysia (Global Economic Indicators, 2002, World Bank).

with a 0.38 percent rise in output of each firm in the supplying industry. As for the determinants, we find that the productivity effect is larger when the multinationals in the sourcing sector are oriented towards supplying the domestic market rather than focusing mainly on exporting. Finally, there is no statistically significant difference between the productivity effects associated with partially- and fully-owned foreign projects.

In summary, this paper adds to the understanding of externalities generated by FDI in a host country economy, which is a hugely important issue for public policy. Our finding of positive correlation between firm productivity and multinational presence in downstream sectors is, however, by no means a call for subsidizing FDI. These results are consistent with the existence of knowledge spillovers from foreign affiliates to their local suppliers but they may also be due to increased competition in upstream sectors. The latter may be the case if multinationals entering downstream sectors force less productive domestic producers to exit thus lowering the demand for domestically produced intermediates, either because they are more efficient and need fewer inputs⁸ or they choose to import their inputs (due to their higher quality, constraints imposed by the parent company, etc.). The welfare implications of the two scenarios are quite different. While the former case would call for FDI incentives, it would not be the optimal policy in the latter. More research is certainly needed to disentangle these effects.

This study is structured as follows. In the next section, we briefly discuss vertical spillovers and their determinants, followed by a description of FDI inflows into Lithuania. Then we introduce our data and the estimation strategy. In the following section, we present the empirical results. We conclude in the closing section.

Vertical Spillovers and Their Determinants

Productivity spillovers from FDI take place when the entry or presence of multinational corporations increases productivity of domestic firms in a host country and the multinationals do not fully internalize the value of these benefits. Spillovers may take place when local firms improve their efficiency by copying technologies of foreign affiliates operating in the local

⁸ See Saggi's (2002) model for such a scenario.

market either based on observation or by hiring workers trained by the affiliates. Another kind of spillovers occurs if multinational entry leads to more severe competition in the host country market and forces local firms to use their existing resources more efficiently or to search for new technologies (Blomström and Kokko, 1998). While the knowledge spillovers present a rationale for government action to subsidize FDI inflows, this is not the case when the improved productivity of local firms is due to increased competition, as inducing greater competition may be achieved by other means (import liberalization, anti-trust policies, etc.).

When local firms benefit from the presence of foreign companies in their sector, we refer to this phenomenon as horizontal spillovers. To the extent that domestic firms compete with multinationals, the latter have an incentive to prevent technology leakage and spillovers from taking place. This can be achieved this through formal protection of their intellectual property, trade secrecy, paying higher wages or locating in countries or industries where domestic firms have limited imitative capacities to begin with.

On the other hand, the term vertical spillovers (in this paper restricted to the backward linkage channel) refers to productivity spillovers taking place due to linkages between foreign firms and their local suppliers. Such spillovers can operate through: (i) direct knowledge transfer from foreign customers to local suppliers;⁹ (ii) higher requirements regarding product quality and on-time delivery introduced by multinationals, which provide incentive to domestic suppliers to upgrade their production management or technology; (iii) indirect knowledge transfer through movement of labor; (iv) increased demand for intermediate products due to multinational entry, which allows local suppliers to reap the benefits of scale economies;¹⁰ (v) competition effect—multinationals acquiring domestic firms may choose to source intermediates abroad thus breaking existing supplier-customer relationships and increasing competition in the intermediate products market.¹¹

⁹ As numerous case studies indicate (see Moran 2001), multinationals often provide technical assistance to their suppliers in order to raise the quality of their products or facilitate innovation. They help suppliers with management training and organization of the production process, purchasing raw materials and even finding additional customers. Note that the existence of linkages does not necessarily guarantee that spillovers take place nor does the fact that multinationals may charge for services provided preclude the presence of spillovers. Spillovers take place when foreign affiliates are unable to extract the full value of the resulting productivity increase through direct payment or lower prices they pay for intermediates sourced from the local firm.

¹⁰ For a theoretical model, see Rivera-Batiz and Rivera-Batiz (1990).

¹¹ One of the largest FDI projects in Romania, Renault's purchase of an equity stake in Dacia, the local automobile maker, may serve as an example. The initial transaction took place in 1999 with subsequent increases in Renault's share in 2001 and 2002. After the acquisition, the French company promised to continue sourcing inputs from local

Now let's turn to factors that could potentially drive vertical spillovers. First, the motivation for undertaking FDI is likely to affect the extent of local sourcing by foreign affiliates. It has been suggested that domestic-market-oriented foreign affiliates tend to purchase more locally than export-oriented ones (UNCTAD 2000; Altenburg 2000; Belderbos et al. 2001). Quality and technical requirements associated with goods targeted for the domestic market may be lower and thus local suppliers may find it easier to serve multinationals focused on the local market. On the other hand, multinationals serving global markets may impose more stringent cost and quality requirements, which may be difficult for local suppliers to meet. Moreover, affiliates which are part of international production systems are likely to be more dependent on global sourcing policies of their parent company and thus have less freedom to choose their own suppliers.

Second, it has been argued that affiliates established through M&As or joint ventures are likely to source more locally than those taking form of greenfield projects (UNCTC 2001). While the latter have to take time and effort to develop local linkages, the former can take advantages of the supplier relationships established by the acquired firm or their local partner. Empirical evidence to support this view has been found for Japanese investors (Belderbos et al., 2001) and for Swedish affiliates in Eastern and Central Europe (UNCTC 2000). In the case of the latter, the difference persisted also in the longer term.¹² While in our dataset we cannot distinguish between acquisitions, joint ventures and greenfield projects, we have information on the extent of foreign ownership. To the extent that full foreign ownership is a proxy for greenfield projects, we expect that fully-owned foreign affiliates may rely more on imported inputs, while investment projects with local capital participation will tend to source more locally. Therefore, backward linkages associated with the latter group are likely to result in greater spillovers.

In what follows, we examine the above hypotheses. Before then, however, we review briefly FDI-related developments in Lithuania.

suppliers provided they lived up to the expectations of the new owner. This, however, does not seem to have been the case. In 2002, eleven foreign suppliers of the French group will start operating in Romania, thus replacing the Romanian producers from whom Dacia used to source. Source: Ziarul Financiar (Financial Newspaper) April 19, 2001.

¹² The results of a study of the largest exporters in Hungary (Toth and Semjen 1999) also indicate that foreign affiliates with larger share of foreign equity tend to purchase fewer inputs from Hungarian companies.

Foreign Direct Investment in Lithuania

Similarly to other former Soviet Republics, Lithuania had been virtually closed to foreign investment before 1990. After regaining its independence in 1990, Lithuania began the process of transition to a market economy and opened its borders to FDI. Yet unlike transition economies of Central and Eastern Europe (CEEC-10 hereafter), it did not receive large FDI inflows until the late 1990s. The first stage of the privatization process, starting in 1991, offered limited opportunities for foreign investors. It was not until 1997 that FDI inflows into Lithuania increased significantly as a result of the second stage of the privatization process (see the chart below). As is evident from Table A below, the overall magnitude of FDI inflows has not been very large. In terms of cumulative FDI inflows per capita during the period 1993-2000, Lithuania ranks eighth among CEEC-10 above Bulgaria and Romania. In terms of the value of cumulative FDI inflows, Lithuania ranks ninth exceeding only FDI receipts of Slovenia.

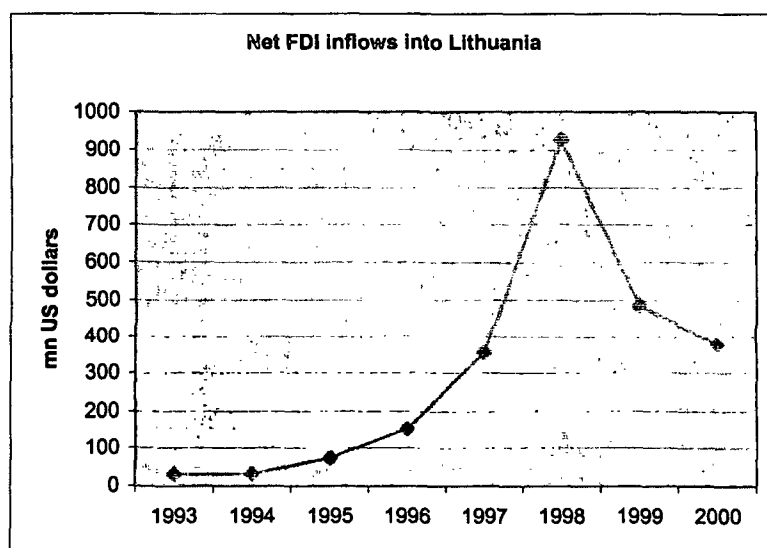


Table A. FDI Inflows into CEEC-10 1993-2000.

	Net FDI inflow (millions of US\$)								FDI inflows 2000		FDI inflows 1993-2000	
	1993	1994	1995	1996	1997	1998	1999	2000	as % of GDP	per capita	Value (mn US\$)	Per capita (US\$)
Czech Republic	654	878	2,568	1,435	1,286	3,700	6,313	4,583	9.3	446	21,417	2,085
Hungary	2,350	1,144	4,519	2,274	2,167	2,037	1,977	1,692	3.7	169	18,159	1,812
Estonia	162	214	201	150	266	581	305	387	7.8	270	2,268	1,580
Poland	1,715	1,875	3,659	4,498	4,908	6,365	7,270	9,342	5.9	242	39,632	1,025
Latvia	45	214	180	382	521	357	348	407	5.7	169	2,454	1,015
Slovenia	113	128	177	194	375	248	181	181	1.0	91	1,597	803
Slovak Republic	199	270	236	351	174	562	354	2,052	10.7	380	4,198	777
Lithuania	30	31	73	152	355	926	486	379	3.4	102	2,432	658
Bulgaria	40	105	90	109	505	537	806	1,002	8.3	123	3,194	391
Romania	94	341	419	263	1,215	2,031	1,041	1,025	2.8	46	6,429	287

Source: IMF International Financial Statistics (FDI figures) and World Bank World Development Indicators (GDP and population)

In terms of sectoral distribution of FDI, 44 percent of FDI stock in 1996 was in manufacturing. After large inflows into telecommunications and financial sector, this figure decreased to 32 percent in 2000. When the number of projects is taken into account, in 1996 20 percent were in manufacturing, as compared to 21 percent in 2000. Within manufacturing, food products, beverages and tobacco attracted the largest share of investment (12 percent of total FDI stock), followed by textiles and leather products (4 percent), refined petroleum and chemicals (4 percent). Electrical machinery and optical instruments as well as wood products also received significant foreign investments. As for service sectors, wholesale and retail trade accounted for a quarter of FDI stock in 2000, telecommunications for 18 percent and financial intermediation for 14 percent.

Data and Methodology

The data used in this study come from the annual enterprise survey conducted by the Lithuanian Statistical Office. The survey coverage is extensive, as firms accounting for about 85 percent of output in each sector are included in the sample. The Lithuanian enterprise data have been praised for their high quality and reliability.¹³ The data constitute an unbalanced panel spanning over the period 1996-2000. The number of firms per year varies from over twelve thousand in 1996 to twenty one thousand in 1999. Due to financial constraints in some years the

¹³ A recent survey examining the quality of data collected by statistical offices ranked Lithuania second among twenty transition economies (see Belkindas et al., 1999).

Statistical Office was forced to reduce the scope of the exercise. In each year, however, the same sampling technique was used. In this study, we restrict our attention to manufacturing firms only (NACE sectors 15-36), which lowers the sample size to 2,500 to 4,000 firms a year. The number of observations is further reduced by missing values. Moreover, we exclude two sectors tobacco (NACE 16) and manufacturing of refined petroleum products (NACE 23), since the small number of firms prevents us from applying the Olley-Pakes technique (discussed below) to these industries. Thus we are left with a sample of between 1,921 and 2,712 firms in a given year. The sectoral distribution of firms in the last year of the sample is presented in Table 1.

In addition to standard financial statements, the dataset contains information on the amount of foreign capital, if any, that has been invested in each firm, which allows us to make comparisons between FDI recipients and locally owned firms. FDI recipients are defined as firms with the foreign share equal to at least ten percent of total capital. More than 12 percent of the total of 11,644 observations pertain to such firms. The dataset also includes information on the share of exports in firm sales.

To examine the correlation between firm productivity and foreign presence in the same industry or downstream sectors, we follow the approach taken by the earlier literature and estimate several variations of the following equation:

$$\ln Y_{it} = \alpha + \beta_1 \ln K_{it} + \beta_2 \ln L_{it} + \beta_3 \ln M_{it} + \beta_4 FS_{it} + \beta_5 Horizontal_{jt} + \beta_6 Backward_{jt} + \alpha_i + \alpha_r + \alpha_j + \varepsilon_{ijrt}$$

Y_{it} stands for firm i 's real output at time t , which is calculated by adjusting the reported sales for changes in inventories of finished goods and deflating the resulting value by the Producer Price Index for the appropriate two-digit NACE sector. K_{it} , capital, is defined as the value of fixed assets at the beginning of the year, deflated by the average of the deflators for four NACE sectors: machinery and equipment; office, accounting and computing machinery; electrical machinery and apparatus; motor vehicles, trailer and semi-trailers; and other transport equipment. L_{it} , employment, is measured by the number of workers.¹⁴ M_{it} , material inputs, are equal to the value of material inputs adjusted for changes in material inventories, deflated by material inputs deflator calculated for each sector based on the two-digit input-output matrix and

¹⁴ Ideally we would like to have information on hours worked but, unfortunately, it is not available. Neither can we distinguish between skilled and unskilled workers.

deflators for the relevant two-digit NACE sectors. FS_{it} measures the share of foreign capital in firm's total capital.

$Horizontal_{jt}$ captures the extent of foreign presence in the sector and is defined as foreign equity participation averaged over all firms in the sector, weighted by each firm's share in sectoral output.¹⁵ In other words,

$$Horizontal_{jt} = [\sum_{i \text{ for all } i \in j} FS_{ijt} * Y_{ijt}] / \sum_{i \text{ for all } i \in j} Y_{ijt}$$

Thus the value of the variable increases with the output of foreign investment enterprises and the share of foreign capital in these firms.

The variable *Backward* is a proxy for the foreign presence in the industries that are being supplied by the sector to which the firm in question belongs and thus is intended to capture the extent of potential contacts between domestic suppliers and multinational customers. It is defined in the following way:

$$Backward_{jt} = \sum_{k \text{ if } k \neq j} \alpha_{jk} Horizontal_{kt}$$

where α_{jk} is the proportion of sector j output supplied to sector k taken from the 1996 input-output matrix at the two-digit NACE level. The proportion is calculated excluding products supplied for final consumption but including imports of intermediate products.¹⁶ As the formula indicates, we do not include inputs supplied within the sector, since we want this effect to be captured by the *Horizontal* variable.¹⁷ Thus the greater the foreign presence in sectors supplied by industry j and the larger the share of intermediates supplied to industries with multinational presence, the higher the value of the variable.

While the coefficients taken from the input-output table remain fixed, we observe changes in foreign presence and firm output during the period in question. Thus variables capturing horizontal and vertical linkages are time-varying sector-specific variables. In addition to the calculation described above, we recalculated the *Horizontal* variable making it firm

¹⁵ This definition is analogous to that in Aitken et al. (1999) who use employment as weights. Blalock (2001) and Schoors et al. (2001) employ output weights but do not take into account the share of foreign equity, treating total output of firms with at least ten percent foreign equity as foreign.

¹⁶ Since relationships between sectors may change over time (although a radical change is unlikely), ideally we would like to use multiple input-output matrices. Unfortunately, input-output matrices for later years are unavailable. Similarly, while we would prefer to use a matrix excluding imports, it is not available. Thus, our results should be interpreted keeping these two caveats in mind.

¹⁷ This approach is followed by Schoors et al. (2001) but not by Blalock (2001). Including the share of intermediates supplied within the sector in the *Backward* measure (as was done in the earlier version of this paper) does not change the conclusions with respect to the correlation between firm productivity and foreign presence in the sourcing sectors.

specific by excluding the output of the firm in question in the calculations. Since both definitions lead to the same qualitative results, we present only the results with the latter measure.¹⁸ Finally, the basic specification of the model also includes year, region and industry dummies. Summary statistics of the variables employed are presented in Table 2.

Several econometric concerns need addressing. The first one is the omission of unobserved variables. There may exist firm, time and region specific factors unknown to econometrician but known to the firm that may affect the correlation between firm productivity and foreign presence. Examples of these variables include high quality management in a particular firm or better infrastructure present in a given region. We address this problem by following Haskel et al. (2002) and using time differencing as well as a full set of fixed effects for year, industry and region. As Haskel et al. point out, in addition to removing any fixed plant-specific unobservable variation, differencing will also remove fixed regional and industrial effects such as infrastructure and technological opportunity. Time, industry and regional fixed effects on the other hand will control for unobservables that may be driving changes in, for instance, attractiveness of a particular region or industry.¹⁹ Thus our specification becomes

$$\begin{aligned} \Delta \ln Y_{it} = & \alpha + \delta_1 \Delta \ln K_{it} + \delta_2 \Delta \ln L_{it} + \delta_3 \Delta \ln M_{it} + \delta_4 \Delta FS_{it} + \delta_5 \Delta Horizontal_{it} \\ & + \delta_6 \Delta Backward_{it} + \alpha_t + \alpha_r + \alpha_j + \varepsilon_{it} \end{aligned}$$

Second, as Djankov and Hoekman (2000) and Evenett and Voicu (2001) have shown, foreign investors tend to acquire stakes in the largest and most successful companies in transition economies. If this issue is not taken into account, the estimation results could be biased. To avoid such a bias, we also estimate our model on a sample of domestic firms only.²⁰ Additionally, we have used the two-step procedure devised by Maddala (1983). The procedure amounted to estimating first a probit model on whether or not firm *i* ever received FDI on firm size (measured by total capital) and profitability (measured by the ratio of gross profits to sales) in the first year of the sample, subsequently not used in the second stage. The estimates from the first stage were then used to form an additional regressor in the second stage estimation of

¹⁸ Note that recalculating the *Horizontal* variable will not affect the *Backward* measure since it does not take into account inputs suppliers to own sector.

¹⁹ As Haskel et al. mention, in this case a fixed effect for region *r* captures not just the fact that region *r* is an attractive business location but that its attractiveness is rising over time.

²⁰ Domestic firms are defined as those with less than ten percent of foreign equity.

productivity on foreign presence, annual and regional dummies. The results (not reported here) led to the same qualitative results.

Third, it has been argued that the use of ordinary least squares may be inappropriate when estimating productivity since this method treats labor and other inputs as exogenous variables. Griliches and Mairesse (1995) have argued that inputs should be considered endogenous since they are chosen by firm based on its productivity, which is observed by the producer but not by the econometrician. Not taking into account the endogeneity of input choices may bias the estimated coefficients. Since the focus of this paper is on firm productivity, the consistency of the estimates is crucial for our analysis. Therefore, we employ the semiparametric estimation procedure suggested by Olley and Pakes (1996).²¹ The details of the procedure are described in the Appendix.

A production function, taking into account the Olley-Pakes correction, is estimated for each industry separately. From this estimation, we recover the measure of total factor productivity, which is the difference between the actual and predicted output, and use it in the estimation of our basic model. Note that the Olley-Pakes procedure rests on the assumption of factors fully adjusting to shocks in each period and markets being perfectly competitive. Since there may be some doubt about the validity of these assumptions, particularly in the context of a transition economy, we present the results both with and without the correction. Further, while this method also allows for controlling for firm exit, we do not utilize this option since, unfortunately, in our dataset we are unable to distinguish between firm exit from the sample due to liquidation or due to not being included in the group of enterprises surveyed in a given year.

The last but not the least econometric concern has been pointed out by Moulton (1990) who shows that in the case of regressions performed on micro units yet including aggregated market (or in our case industry) variables the standard errors from ordinary least squares will be underestimated. As he demonstrates, failing to take this into account will lead to a serious downward bias in the estimated errors resulting in spurious finding of statistical significance for the aggregate variable of interest. To address this issue, we correct the standard errors for a correlation between observations for the same industry in a given year (in other words, we cluster standard errors for all observations for the same industry and year).

²¹ This method has been recently applied by, for instance, Pavcnik (2002).

To the best of our knowledge, none of the earlier spillover studies has taken into account all of the above concerns. As for the papers on vertical spillovers, Schoors et al. (2001) employ a two-step selection procedure but do not include firm or industry fixed effects (since their dataset pertains to only a two-year period), while Blalock (2001) controls for firm fixed effects but not the selection issue. Neither study includes differencing of spillover variables, correction for endogeneity of input choices or correction of errors for the downward bias pointed out by Moulton (1990).

Estimation Results

The results from the first differences model described in the previous section are presented in Table 3. The first two columns contain the coefficients estimated for the full sample followed by those for the subsample of domestic firms. All of them pertain to the model without the Olley-Pakes correction. As expected, we find positive and significant coefficients on changes in all production inputs as well as on change in the share of foreign equity. This implies that an increase in foreign capital participation in a given firm is associated with a faster output growth. As in the earlier studies, the coefficient on the proxy for horizontal spillovers does not appear to be statistically significant. More importantly for this study, we find a positive and significant coefficient on the measure of backward linkages both in the full sample and the subsample of domestic firms. The magnitude of the effect is economically meaningful as a ten percent increase in the foreign presence in downstream sectors is associated with a 0.38 percent rise in output of each domestic firm in the supplying industry.²²

When the Olley-Pakes correction is applied (see the last four columns of Table 3), the coefficients on the backward variable are positive but not significant at the conventional levels. As before, we find a positive correlation between the change in the foreign equity share and firm productivity growth but no indication of the presence of horizontal spillovers.

In Table 4 we repeat the exercise, this time however focusing on second differences. Looking at a longer time period produces a higher R^2 , which is equal to about 0.54, as opposed

²² For comparison, in their study of horizontal spillovers in the UK, Haskel et al. (2001) found that a rise of ten percentage points in foreign presence in the *same* industry would increase output in each domestic plant *in that industry* by 0.5 percent.

to 0.38 in the previous table. Again we find positive and significant correlation between the extent of foreign presence in downstream sectors and firm productivity. This is the case for the full sample as well as domestic firms, but only in the case when the Olley-Pakes correction is not applied. We also find positive correlation between foreign presence in the same sector and productivity of domestic firms. This is not true, however, for the full sample or when we correct for the endogeneity of input choices.

The next issue we turn to is whether potential spillovers operate at the regional or national level. To examine this question we calculate the *Backward* measure for the region of the firm in question as well as for all other regions. Since Lithuania is a relatively small country, for the purpose of this exercise we focus on ten regions. Analogously, we compute one measure of horizontal spillovers for the region where the firm in question is located and another measure pertaining to all other regions. Note that the measures pertaining to own region are firm specific since they exclude the output of the firm in question. Since in this model, we do not face the problem of industry-specific variables and firm-specific observations, we do not cluster standard errors for industry and instead apply a general correction for heteroskedasticity.

The results presented in Table 5 show a positive and significant correlation between firm productivity and foreign presence in downstream sectors in the same region. The coefficients are significant in all eight regressions, even when the Olley-Pakes correction is applied. The coefficients are larger in magnitude and more significant in the case of the domestic firm subsample. As for the impact of downstream multinationals in other regions, this effects is positive and significant only in the first four columns of the table. The proxies for foreign presence in the same sector (both in the same region and other parts of the country) do not appear to be statistically significant.

As mentioned before, case studies and evidence based on particular sectors suggest that domestic-market-oriented affiliates tend to source more locally than the affiliates focused on exporting. And since the extent of spillovers is likely to be correlated with the intensity of contacts between domestic firms and multinationals, we would expect to observe greater spillovers associated with domestic-market-oriented affiliates. To examine this question, we calculate two separate measures of backward linkages: one for affiliates exporting more than half

of their output and one for foreign firms selling at least half of their output locally. The latter variable is defined as follows:

*Backward (Domestic-Market-Oriented)*_{jt} = $\sum_{k \text{ if } k \neq j} \alpha_{jk} * [\sum_i FS_{ikt} * DMO_{ikt} * Output_{ikt}] / \sum_i Output_{ikt}$
 where $DMO_{ikt} = 1$ if firm i sold at least half of its output in the local market. Otherwise, it takes on the value of zero. The measure for export-oriented affiliates is calculated analogously. We include both measures in our model keeping the horizontal variable defined as before.

The results presented in Table 6 provide some support for the hypothesis. While we find that in all eight regressions, both backward measures are positive and statistically significant, their coefficients are larger in the case of domestic-market-oriented affiliates. The difference in magnitude between the two types of backward measures is statistically significant at the one percent level in four cases, five percent in two cases and ten percent in the remaining two regressions.

Next we turn to the hypothesis that backward linkages associated with partially-owned foreign projects lead to greater spillovers than linkages to wholly-owned foreign affiliates. To examine this question we calculate two measures of backward linkages: one for firms with the share of foreign capital equal to at least 99 percent and one for remaining enterprises with foreign participation.²³

The results shown in Table 7, however, lend little support to the hypothesis. While we find evidence of significant positive spillovers associated with jointly-owned foreign affiliates but no evidence of spillovers in the case of wholly-owned foreign projects, the difference between the magnitudes of the coefficients is not statistically significant. Moreover, when the Olley-Pakes correction is applied, the backward variables do not appear to be statistically significant.

²³ There are 262 observations pertaining to fully owned foreign affiliates and further 25 observations for firms with foreign capital share of more than 99 and less than 100 percent.

Conclusions

Many countries, including developing and transition economies, compete against one another in attracting foreign investors by offering ever more generous incentive packages and justifying their actions with the productivity gains that are expected to accrue to domestic producers from knowledge externalities generated by foreign affiliates. Despite this question being hugely important to public policy choices, there is little conclusive evidence to support this claim.

This study is an effort to further our understanding of this issue. It examines whether there exists a correlation between productivity growth of domestic firms and the presence of foreign affiliates in downstream sectors. It improves over the existing literature by focusing on the understudied issue of FDI spillover through backward linkages (i.e., contacts between foreign affiliates and their local suppliers) rather than the horizontal channel (i.e., benefits enjoyed by domestic firms from foreign presence in their sector) and going beyond the existing studies by shedding some light on factors driving this phenomenon. This study also addresses several econometric problems that may have biased the results of the earlier research.

The estimation results, based on a firm-level panel data set from Lithuania, are consistent with the presence of productivity spillovers taking place through backward linkages. They suggest that a rise of ten percent in the foreign presence in downstream industries is associated with a 0.38 percent increase in output of each domestic firm in the upstream sector. Moreover, the data indicate that such spillovers are not restricted geographically, since local firms seem to benefit from the operation of foreign affiliates in their own region as well as in other parts of the country. Further, we find that greater productivity benefits are associated with domestic-market-rather than export-oriented foreign companies. We detect no difference, however, between the effects of fully-owned foreign firms and those with joint domestic and foreign ownership.

As is often the case with empirical studies, our results are subjects to several caveats. Our definitions of industries are quite broad and thus inevitably we may be lumping together producers of products that are significantly different. Moreover, given the data limitation, we are unable to control for firm entry and exit. Finally, we want to stress that our findings of a positive correlation between productivity growth enjoyed by domestic firms and the increase in multinational presence in downstream sectors should not be interpreted as a call for subsidizing

FDI. These results are consistent with the existence of knowledge spillovers from foreign affiliates to their local suppliers but they may also be due to increased competition in upstream sectors. While the former case would call for offering FDI incentive packages, it would not be the optimal policy in the latter. Further research is certainly needed to disentangle different channels through which FDI spillovers operate.

Bibliography

- Aitken, Brian J. and Ann E. Harrison. 1999. "Do Domestic Firms Benefit from Direct Foreign Investment? Evidence from Venezuela," *American Economic Review*. 89(3): 605-618
- Altenburg, Tilman. 2000. "Linkages and Spillovers between Transnational Corporations and Small and Medium-sized Enterprises in Developing Countries: Opportunities and Best Policies," in UNCTAD, *TNC-SME Linkages for Development: Issues-Experiences-Best Practices*. New York and Geneva: United Nations.
- Belderbos, Rene, Giovanni Capannelli and Kyoji Fukao. 2001. "Backward vertical linkages of foreign manufacturing affiliates: Evidence from Japanese multinationals," *World Development*, 29(1): 189-208.
- Belkindas, Misha, Mustafa Dinc, and Olga Ivanova. 1999. "Statistical Systems Need Overhaul in Transition Economies", *Transition*, 10(4), The World Bank, Washington, DC.
- Blalock, Garrick. 2001. "Technology from Foreign Direct Investment: Strategic Transfer through Supply Chains," mimeo, Haas School of Business, University of California, Berkeley.
- Blomström, Magnus. 1989. *Foreign investment and spillovers*. London: Routledge.
- Blomström, Magnus and Ari Kokko. 1998. "Multinational Corporations and Spillovers," *Journal of Economic Surveys*, 12(2): 1-31.
- Blomström, Magnus, Ari Kokko and Mario Zejan. 2000. *Foreign Direct Investment: Firm and Host Country Strategies*. Macmillan Press: London.
- Blomström, Magnus and Hakan Persson. 1983. "Foreign Investment and Spillover Efficiency in an Underdeveloped Economy: Evidence from the Mexican Manufacturing Industry," *World Development*, 11(6): 493-501.
- Blomström, Magnus and Edward W. Wolff. 1994. "Multinational Corporations and Productivity Convergence in Mexico," in W. Baumol, R. Nelson and E. Wolff (eds.) *Convergence of Productivity: Cross-national Studies and Historical Evidence*. Oxford: Oxford University Press.
- Caves, Richard E. 1974. "Multinational Firms, Competition and Productivity in Host-Country Markets," *Economica*, 41(162): 176-93.
- Csaki, Gyorgy. 2001. "From Transition to Integration: FDI Inflows into Hungary, a Success Story of the Hungarian Transition," mimeo, Budapest College of Management.
- Djankov, Simeon and Bernard Hoekman. 2000. "Foreign Investment and Productivity Growth in Czech Enterprises," *World Bank Economic Review*, 14(1): 49-64.
- Evenett, Simon. J. and Alexandru Voicu. 2001. "Picking Winners or Creating Them? Revisiting the Benefits of FDI in the Czech Republic?" mimeo, the World Bank.
- Görg, Holger and Eric Strobl. 2001. "Multinational Companies and Productivity Spillovers: A Meta-Analysis." *The Economic Journal*, 111: 723-39.
- Griliches, Z. and J. Mairesse. 1995. "Production Functions: the Search for Identification," NBER Working Paper 5067.

- Haddad, Mona and Ann Harrison. 1993. "Are there positive spillovers from direct foreign investment? Evidence from panel data for Morocco," *Journal of Development Economics*, 42: 51-74.
- Haskel, Jonathan E., Sonia C. Pereira and Matthew J. Slaughter. 2002. "Does Inward Foreign Direct Investment Boost the Productivity of Domestic Firms?" NBER Working Paper 8724.
- Kokko, Ari, Ruben Tansini and Mario Zejan. 1996. "Local Technological Capability and Productivity Spillovers from FDI in the Uruguayan Manufacturing Sector," *Journal of Development Studies*. 32(4): 602-620.
- Kugler, Maurice. 2000. "The Diffusion of Externalities from Foreign Direct Investment: Theory Ahead of Measurement," Discussion Papers in Economics and Econometrics, University of Southampton, U.K.
- Maddala, G.S. 1983. *Limited-dependent and Qualitative Variables in Econometrics*. Cambridge: Cambridge University Press.
- Markusen, James R. and Anthony J. Venables. 1999. "Foreign direct investment as a catalyst for industrial development," *European Economic Review*. 43(1999): 335-356.
- Moran, Theodore. 2001. *Parental Supervision: the new paradigm for foreign direct investment and development*. Institute for International Economics, Washington, DC.
- Moulton, Brent R. "An Illustration of a Pitfall in Estimating the Effects of Aggregate Variables on Micro Units," *Review of Economics and Statistics*, 72(2): 334-338.
- Olley, Steven G. and Ariel Pakes. 1996. "The Dynamics of Productivity in the Telecommunications Equipment Industry," *Econometrica* 64(6), pp. 1263-1297.
- Pavcnik, Nina. 2002. "Trade Liberalization, Exit, and Productivity Improvements: Evidence from Chilean Plants," *The Review of Economic Studies*, 69: 245-76
- Rhee, Jong Wong and Therese Belot. 1990. "Export Catalysts in Low-Income Countries: A Review of Eleven Success Stories," World Bank Discussion Paper No. 72, Washington, DC.
- Rivera-Batiz, F. and L. Rivera-Batiz. 1990. "The effects of direct foreign investment in the presence of increasing returns due to specialization," *Journal of Economic Development*, 34(2): 287-307.
- Rodrik, Dani. 1999. "The new global economy and developing countries: making openness work", Policy Essay nr. 24, Overseas Development Council; John Hopkins Univ. Press, Washington DC.
- Rodriguez-Clare, Andres. 1996. "Multinationals, linkages, and economic development," *American Economic Review* 85, pp. 852-73.
- Saggi, Kamal. 2002. "Backward Linkages under Foreign Direct Investment," mimeo, Southern Methodist University.
- Schoors, Koen and Bartoldus van der Tol. 2001. "The productivity effect of foreign ownership on domestic firms in Hungary," mimeo, University of Gent.

- Toth, Istvan Janos and Andras Semjen. 1999. "Market Links and Growth Capacity of Enterprises in A Transforming Economy: The Case of Hungary," in Istvan Janos Toth and Andras Semjen *Market Links, Tax Environment and Financial Discipline of Hungarian Enterprises*, Institute of Economics, Hungarian Academy of Sciences, Budapest.
- Tybout, James. 2001. "Plant- and Firm-Level Evidence on "New" Trade Theories," Pennsylvania State University, mimeo.
- UNCTAD. 2000. *The Competitiveness Challenge: Transnational Corporations and Industrial Restructuring in Developing Countries*. New York and Geneva: United Nations.
- UNCTC. 2001. *World Investment Report. Promoting Linkages*. New York and Geneva: United Nations.

Table 1. Distribution of Firms with Foreign Capital by Industry (number of firms in 2000)

NACE		Domestically Owned Firms	Firms with Foreign Capital*	All Firms	Share of Firms with Foreign Capital in the sector (%)
15	Manuf. of food products and beverages	437	55	492	11
17	Manuf. of textiles	84	34	118	29
18	Manuf. of wearing apparel; dressing, dyeing of fur	201	49	250	20
20	Manuf. of wood & wood products except furniture	432	47	479	10
22	Publishing, printing & reproduction of recorded media	225	12	237	5
24	Manuf. of chemicals & chemical products	48	17	65	26
25	Manuf. of rubber & plastic products	118	25	143	17
26	Manuf. of other non-metallic mineral products	148	18	166	11
28	Manuf. of fabricated metal products, exc. machinery	169	25	194	13
29	Manuf. of machinery & equipment n.e.c	106	13	119	11
31	Manuf. of electrical mach. & apparatus n.e.c.	43	5	48	10
32	Manuf. of radio, tv, communication equipment	28	5	33	15
33	Manuf. of medical, precision & optical instruments, watches	46	9	55	16
35	Manuf. of other transport equipment	40	8	48	17
36	Manuf. of furniture; manufacturing n.e.c.	169	20	189	11
Total		2,294	342	2,636	13

* foreign share of at least 10 percent of total capital

Table 2. Summary Statistics

Variable	No. of obs.	Mean	Std. Dev.	Min	Max
Output	11,652	5,587,446	24,300,000	11	660,000,000
No. of employees	11,652	84	238	1	6,176
Fixed Assets	11,652	2,587,088	11,000,000	10	298,000,000
Material Inputs	11,652	2,898,996	13,300,000	2	376,000,000
Gross Investment	11,652	429,823	2,681,202	0	82,300,000
Foreign capital share (%)	11,644	7.8	23.0	0	100.0
Exports/Output (%)	9,776	21.0	34.0	0	100.0
Horizontal (%)	11,644	19.7	12.3	0	79.5
Horizontal same region (%)	11,633	15.8	15.6	0	100.0
Horizontal other region (%)	11,652	19.3	13.9	0	81.0
Backward (%)	11,652	4.9	4.0	0	17.2
Backward same region (%)	11,652	2.8	2.9	0	30.0
Backward other region (%)	11,652	4.3	3.8	0	18.5
Backward (Export-oriented MNCs)	11,652	3.1	2.6	0	16.6
Backward (Local-market-oriented MNCs)	11,652	1.8	2.0	0	13.4
Backward (Full ownership)	11,652	1.9	2.0	0	14.7
Backward (Shared ownership)	11,652	3.0	2.5	0	8.9

Table 3. Regressions in First Differences

	All firms		Domestic firms		with Olley-Pakes correction			
					All firms		Domestic firms	
$\Delta \ln L$	0.373*** (0.019)	0.373*** (0.019)	0.360*** (0.021)	0.359*** (0.021)				
$\Delta \ln K$	0.040*** (0.013)	0.040*** (0.013)	0.038*** (0.012)	0.039*** (0.012)				
$\Delta \ln M$	0.212*** (0.020)	0.212*** (0.020)	0.212*** (0.019)	0.212*** (0.019)				
Δ Foreign share	0.001** (0.001)	0.001** (0.001)			0.001** (0.001)	0.001** (0.001)		
Δ Backward	0.038* (0.019)	0.038* (0.019)	0.038* (0.021)	0.038* (0.021)	0.030 (0.025)	0.030 (0.025)	0.030 (0.027)	0.030 (0.027)
Δ Horizontal		-0.001 (0.002)		0.000 (0.002)		0.000 (0.002)		0.000 (0.003)
Intercept	-0.056 (0.056)	-0.054 (0.057)	-0.068 (0.049)	-0.070 (0.050)	-0.057 (0.058)	-0.055 (0.057)	-0.075 (0.057)	-0.078 (0.057)
Year dummies	yes	yes	yes	yes	yes	yes	yes	yes
Industry dummies	yes	yes	yes	yes	yes	yes	yes	yes
Regional dummies	yes	yes	yes	yes	yes	yes	yes	yes
No. of obs.	6862	6862	5925	5923	6862	6862	5925	5923
F-stat	51.96	50.56	42.4	42.38	2.86	2.77	2.15	2.13
Prob > F	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
R ²	0.38	0.38	0.37	0.37	0.01	0.01	0.01	0.01

Standard errors have been corrected for clustering for each industry in each year. ***, **, * denote significance at 1, 5 and 10% level.

Table 4. Regressions in Second Differences

					with Olley-Pakes correction			
	All firms		Domestic firms		All firms		Domestic firms	
$\Delta \ln L$	0.486***	0.486***	0.487***	0.486***				
	(0.028)	(0.028)	(0.032)	(0.032)				
$\Delta \ln K$	0.050***	0.051***	0.051***	0.051***				
	(0.012)	(0.012)	(0.013)	(0.013)				
$\Delta \ln M$	0.291***	0.291***	0.287***	0.287***				
	(0.029)	(0.029)	(0.026)	(0.026)				
Δ Foreign share	0.001	0.001			0.001	0.001		
	(0.001)	(0.001)			(0.001)	(0.001)		
Δ Backward	0.032*	0.028*	0.037**	0.030*	0.022	0.018	0.023	0.017
	(0.017)	(0.015)	(0.018)	(0.016)	(0.016)	(0.016)	(0.016)	(0.017)
Δ Horizontal		0.003		0.004*		0.003		0.004
		(0.003)		(0.003)		(0.002)		(0.003)
Intercept	-0.096**	-0.117**	-0.114**	-0.141**	-0.107**	-0.125**	-0.113*	-0.135**
	(0.046)	(0.054)	(0.056)	(0.063)	(0.046)	(0.051)	(0.057)	(0.063)
Year dummies	yes	yes	yes	yes	yes	yes	yes	yes
Industry dummies	yes	yes	yes	yes	yes	yes	yes	yes
Regional dummies	yes	yes	yes	yes	yes	yes	yes	yes
No. of obs.	4557	4557	3929	3929	4557	4557	3929	3929
F-stat	213.16	207.94	128.86	139.34	23.06	34.58	45	35.04
Prob > F	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
R ²	0.54	0.54	0.53	0.53	0.03	0.03	0.03	0.03

Standard errors have been corrected for clustering for each industry in each year. ***, **, * denote significance at the 1, 5 and 10% level.

Table 5. Regressions in First Differences. Intra- versus Inter-regional Spillovers

					with Olley-Pakes correction			
	All firms		Domestic firms		All firms		Domestic firms	
$\Delta \ln L$	0.372*** (0.018)	0.372*** (0.018)	0.359*** (0.019)	0.359*** (0.019)				
$\Delta \ln K$	0.040*** (0.010)	0.040*** (0.010)	0.038*** (0.011)	0.039*** (0.011)				
$\Delta \ln M$	0.213*** (0.011)	0.212*** (0.011)	0.212*** (0.011)	0.212*** (0.011)				
Δ Foreign share	0.001** (0.001)	0.001** (0.001)			0.001* (0.001)	0.001* (0.001)		
Δ Backward same region	0.016** (0.007)	0.016** (0.007)	0.019*** (0.007)	0.019*** (0.007)	0.015* (0.008)	0.015* (0.008)	0.018** (0.008)	0.017** (0.008)
Δ Backward other region	0.021** (0.010)	0.021** (0.010)	0.024** (0.010)	0.023** (0.010)	0.017 (0.011)	0.017 (0.011)	0.018 (0.012)	0.018 (0.013)
Δ Horizontal same region		0.000 (0.001)		-0.001 (0.001)		0.000 (0.001)		0.000 (0.001)
Δ Horizontal other region		0.001 (0.001)		0.000 (0.001)		0.000 (0.002)		0.000 (0.002)
Intercept	-0.060** (0.030)	-0.062** (0.031)	-0.072** (0.033)	-0.074** (0.033)	-0.059* (0.033)	-0.060* (0.034)	-0.078** (0.037)	-0.080** (0.038)
Year dummies	yes	yes	yes	yes	yes	yes	yes	yes
Industry dummies	yes	yes	yes	yes	yes	yes	yes	yes
Regional dummies	yes	yes	yes	yes	yes	yes	yes	yes
No. of obs.	6862	6853	5925	5923	6862	6853	5925	5923
F-stat	42.06	39.96	38.36	36.35	2.61	2.44	2.17	2.10
Prob > F	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
R ²	0.38	0.38	0.37	0.37	0.01	0.01	0.01	0.01

Robust standard errors. ***, **, * denote significance at the 1, 5 and 10% level.

Table 6. Regressions in First Differences. Spillovers Associated with Export- versus Domestic-market-oriented Foreign Affiliates

					with Olley-Pakes correction			
	All firms		Domestic firms		All firms		Domestic firms	
$\Delta \ln L$	0.373***	0.373***	0.360***	0.360***				
	(0.019)	(0.019)	(0.021)	(0.021)				
$\Delta \ln K$	0.040***	0.040***	0.038***	0.039***				
	(0.013)	(0.013)	(0.012)	(0.012)				
$\Delta \ln M$	0.213***	0.213***	0.213***	0.212***				
	(0.020)	(0.020)	(0.019)	(0.019)				
Δ Foreign share	0.001*	0.001*			0.001**	0.001*		
	(0.001)	(0.001)			(0.001)	(0.001)		
Δ Backward (export-oriented)	0.033**	0.033**	0.032**	0.032**	0.028*	0.028*	0.028*	0.028*
	(0.013)	(0.013)	(0.013)	(0.013)	(0.016)	(0.016)	(0.016)	(0.016)
Δ Backward (local-market-oriented)	0.049***	0.050***	0.058***	0.058***	0.050**	0.050**	0.059***	0.059**
	(0.017)	(0.017)	(0.017)	(0.017)	(0.022)	(0.022)	(0.023)	(0.023)
Δ Horizontal		-0.001		0.000		-0.001		0.000
		(0.002)		(0.002)		(0.002)		(0.003)
Intercept	-0.057	-0.052	-0.071	-0.071	-0.058	-0.055	-0.078	-0.080
	(0.057)	(0.059)	(0.051)	(0.052)	(0.059)	(0.059)	(0.059)	(0.058)
Year dummies	yes	yes	yes	yes	yes	yes	yes	yes
Industry dummies	yes	yes	yes	yes	yes	yes	yes	yes
Regional dummies	yes	yes	yes	yes	yes	yes	yes	yes
No. of obs.	6862	6862	5925	5923	6862	6862	5925	5923
F-stat	56.11	54.57	43.73	43.28	3.1	3.01	2.86	2.93
Prob > F	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
R ²	0.38	0.38	0.38	0.38	0.02	0.02	0.02	0.02
BK (export) diff from BK (local-mkt-or)	yes(5%)	yes(10%)	yes(1%)	yes(1%)	yes (5%)	yes (6%)	yes (1%)	yes (1%)

Standard errors have been corrected for clustering for each industry in each year. ***, **, * denote significance at the 1, 5 and 10% level.

Table 7. Regresions in First Differences. Spillovers Associated with Fully- versus Partially-Owned Foreign Affiliates

					with Olley-Pakes correction			
	All firms		Domestic firms		All firms		Domestic firms	
$\Delta \ln L$	0.373*** (0.019)	0.373*** (0.019)	0.360*** (0.021)	0.359*** (0.021)				
$\Delta \ln K$	0.040*** (0.013)	0.040*** (0.013)	0.038*** (0.012)	0.039*** (0.012)				
$\Delta \ln M$	0.212*** (0.020)	0.213*** (0.020)	0.212*** (0.019)	0.212*** (0.019)				
Δ Foreign share	0.001** (0.001)	0.001** (0.001)			0.001** (0.001)	0.001** (0.001)		
Δ Backward (fully-owned)	0.029 (0.025)	0.028 (0.025)	0.041 (0.028)	0.041 (0.029)	0.011 (0.031)	0.011 (0.031)	0.012 (0.035)	0.012 (0.035)
Δ Backward (partially-owned)	0.040* (0.020)	0.040* (0.020)	0.037* (0.023)	0.037* (0.023)	0.034 (0.025)	0.034 (0.025)	0.033 (0.028)	0.033 (0.028)
Δ Horizontal		-0.001 (0.002)		0.000 (0.002)		-0.001 (0.002)		0.000 (0.003)
Intercept	-0.054 (0.057)	-0.051 (0.058)	-0.069 (0.049)	-0.071 (0.050)	-0.051 (0.060)	-0.048 (0.060)	-0.070 (0.059)	-0.072 (0.059)
Year dummies	yes	yes	yes	yes	yes	yes	yes	yes
Industry dummies	yes	yes	yes	yes	yes	yes	yes	yes
Regional dummies	yes	yes	yes	yes	yes	yes	yes	yes
No. of obs.	6862	6862	5925	5923	6862	6862	5925	5923
F-stat	53.93	52.17	40.77	40.96	3.5	3.41	2.2	2.19
Prob > F	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
R-squared	0.38	0.38	0.37	0.37	0.01	0.01	0.01	0.01
BK (fully) diff from BK (part)	no	no	no	no	no	no	no	no

Standard errors have been corrected for clustering for each industry in each year. ***, **, * denote significance at the 1, 5 and 10% level.

Appendix

Estimation Procedure with Olley-Pakes Correction

We employ the semi-parametric estimation of the production function parameters suggested by Olley and Pakes (1996) to account for the endogeneity of input selection by the firm.

We assume that at the beginning of every period a firm chooses variable factors (labor) and a level of investment, which together with the current capital value determine the capital stock at the beginning of the next period. The capital accumulation equation is given by

$$k_{t+1} = (1 - \delta)k_t + i_t \quad (1)$$

where k =capital and i =investment.

We start with the following Cobb-Douglas production function model:

$$y_{it} - m_{it} = \alpha + \beta_l * l_{it} + \beta_k * k_{it} + \omega_{it} + \eta_{it} \quad (2)$$

where $y-m$ =log (output-materials)=log of value added, l =log of labor, and subscripts i and t stand for firm and time, respectively. ω denotes productivity, and η stands for either measurement error (which can be serially correlated) or a shock to productivity which is not forecastable during the period in which labor can be adjusted. Both ω and η are unobserved. The difference is that ω is a state variable in the firm's decision problem and thus affects the input demand while η does not. Labor is assumed to be a freely variable input. Capital is a fixed factor and is only affected by the distribution of ω conditional on information at time $t-1$ and past values of ω .

Since the unobserved productivity shock ω is assumed to be correlated with k_{it} , the estimated coefficient β_k will be biased. The insight of the method is that the observable characteristics of the firm can be modeled as a monotonic function of the productivity of the firm. Inverting such a function allows us to model the unobserved component of the productivity as a function of the observed variables, namely investment.

The investment decision depends on capital stock and firm productivity:

$$i_t = i_t(\omega_t, k_t) \quad (3)$$

By inverting the above equation, we can express unobserved productivity ω as a function of observable investment and capital and thus we are able to control for ω in estimation.

$$\omega_t = h_t(i_t, k_t) \quad (4)$$

By substituting (4) into (2), we obtain the equation to be estimated in the first stage of the procedure:

$$y_{it} - m_{it} = \alpha + \beta_l * l_{it} + \beta_k * k_{it} + h(i_{it}, k_{it}) + \eta_{it} \quad (5)$$

The functional form of $h(\cdot)$ is not known. Therefore, the β_l and β_k coefficients cannot be estimated at this stage. We estimate the partially linear model using a third order polynomial expansion in capital and investment to approximate the form of the $h(\cdot)$.²⁴ From this stage we have the consistent estimate of the labor input coefficient (β_l) as well as the estimate of the third order polynomial in i_{it} and k_{it} , which we refer to as ψ_{it} .

$$\psi_{it} = \alpha + \beta_k * k_{it} + h(i_{it}, k_{it}) \quad (6)$$

Thus,

$$h(i_{it}, k_{it}) = \psi_{it} - \beta_k * k_{it} \quad (7)$$

The second step of the estimation procedure considers the expectation of $y_{t+1} - m_{t+1} - \beta_l * l_{t+1}$

$$\begin{aligned} E[y_{t+1} - m_{t+1} - \beta_l * l_{t+1} | k_{t+1}] \\ = \alpha + \beta_k * k_{t+1} + E[\omega_{t+1} | \omega_t] \\ \equiv \beta_k * k_{t+1} + g(\omega_t) \end{aligned} \quad (8)$$

Assuming that ω_{it} is serially correlated, we can rewrite ω_{it+1} as a function of ω_t , letting ξ_{t+1} be the innovation in ω_{it+1} . Using (4) and (7), the above equation becomes a function of i_{it} and k_{it}

$$y_{t+1} - m_{t+1} - \beta_l * l_{t+1} = \beta_k * k_{t+1} + g(\psi_t - \beta_k * k_t) + \xi_{t+1} + \eta_{t+1} \quad (9)$$

where g is the third order polynomial of $\psi_t - \beta_k * k_t$. This is the equation to be estimated in the second stage of the procedure. Only in this stage we are able to obtain consistent estimates of β_k . Since the capital in use in a given period is assumed to be known at the beginning of the period and ξ_{t+1} is mean independent of all variables known at the beginning of the period, ξ_{t+1} is mean independent of k_{t+1} . We use the non-linear least squares to estimate the above equation.

²⁴ Olley and Pakes (1996) suggest both a kernel and a series estimator, but favor the former since its limiting distribution is known.

Policy Research Working Paper Series

Title	Author	Date	Contact for paper
WPS2895 Telecommunications Reform in Côte d'Ivoire	Jean-Jacques Laffont Tchéché N'Guessan	September 2002	P. Sintim-Aboagye 38526
WPS2896 The Wage Labor Market and Inequality in Vietnam in the 1990s	John Luke Gallup	September 2002	E. Khine 37471
WPS2897 Gender Dimensions of Child Labor and Street Children in Brazil	Emily Gustafsson-Wright Hnin Hnin Pyne	October 2002	M. Correia 39394
WPS2898 Relative Returns to Policy Reform: Evidence from Controlled Cross-Country Regressions	Alexandre Samy de Castro Ian Goldin Luiz A. Pereira da Silva	October 2002	R. Yazigi 37176
WPS2899 The Political Economy of Fiscal Policy and Economic Management in Oil-Exporting Countries	Benn Eifert Alan Gelb Nils Borje Tallroth	October 2002	J. Schwartz 32250
WPS2900 Economic Structure, Productivity, and Infrastructure Quality in Southern Mexico	Uwe Deichmann Marianne Fay Jun Koo Somik V. Lall	October 2002	Y. D'Souza 31449
WPS2901 Decentralized Creditor-Led Corporate Restructuring: Cross-Country Experience	Marinela E. Dado Daniela Klingebiel	October 2002	R. Vo 33722
WPS2902 Aid, Policy, and Growth in Post-Conflict Societies	Paul Collier Anke Hoeffler	October 2002	A. Kitson-Walters 33712
WPS2903 Financial Globalization: Unequal Blessings	Augusto de la Torre Eduardo Levy Yeyati Sergio L. Schmukler	October 2002	P. Soto 37892
WPS2904 Law and Finance: Why Does Legal Origin Matter?	Thorsten Beck Aslı Demirgüç-Kunt Ross Levine	October 2002	K. Labrie 31001
WPS2905 Financing Patterns Around the World: The Role of Institutions	Thorsten Beck Aslı Demirgüç-Kunt Vojislav Maksimovic	October 2002	K. Labrie 31001
WPS2906 Macroeconomic Effects of Private Sector Participation in Latin America's Infrastructure	Lourdes Trujillo Noelia Martín Antonio Estache Javier Campos	October 2002	G. Chenet-Smith 36370
WPS2907 The Case for International Coordination of Electricity Regulation: Evidence from the Measurement of Efficiency in South America	Antonio Estache Martin A. Rossi Christian A. Ruzzier	October 2002	G. Chenet-Smith 36370
WPS2908 The Africa Growth and Opportunity Act and its Rules of Origin: Generosity Undermined?	Aaditya Mattoo Devesh Roy Arvind Subramanian	October 2002	P. Flewitt 32724
WPS2909 An Assessment of Telecommunications Reform in Developing Countries	Carsten Fink Aaditya Mattoo Randeep Rathindran	October 2002	P. Flewitt 32724

Policy Research Working Paper Series

	Title	Author	Date	Contact for paper
WPS2910	Boondoggles and Expropriation: Rent-Seeking and Policy Distortion when Property Rights are Insecure	Philip Keefer Stephen Knack	October 2002	P. Sintim-Aboagye 38526
WPS2911	Micro-Level Estimation of Welfare	Chris Elbers Jean O. Lanjouw Peter Lanjouw	October 2002	P. Sader 33902
WPS2912	Short-Run Pain, Long-Run Gain: The Effects of Financial Liberalization	Graciela Laura Kaminsky Sergio L. Schmukler	October 2002	E. Khine 37471
WPS2913	Financial Development and Dynamic Investment Behavior: Evidence from Panel Vector Autoregression	Inessa Love Lea Zicchino	October 2002	K. Labrie 31001
WPS2914	The Impact of Cash Budgets on Poverty Reduction in Zambia: A Case Study of the Conflict between Well- Intentioned Macroeconomic Policy and Service Delivery to the Poor	Hinh T. Dinh Abebe Adugna Bernard Myers	October 2002	D. Sidibe 35074
WPS2915	Federal Politics and Budget Deficits: Evidence from the States of India	Stuti Khemani	October 2002	H. Sladovich 37698
WPS2916	Ex-ante Evaluation of Conditional Cash Transfer Programs: The Case of Bolsa Escola	François Bourguignon Francisco H. G. Ferreira Phillippe G. Leite	October 2002	P. Sader 33902
WPS2917	Economic Development, Competition Policy, and the World Trade Organization	Bernard Hoekman Petros C. Mavroidis	October 2002	R. Martin 39065
WPS2918	Reducing Agricultural Tariffs versus Domestic Support: What's More Important for Developing Countries?	Bernard Hoekman Francis Ng Marcelo Olarreaga	October 2002	R. Martin 39065
WPS2919	Financial Regulatory Harmonization and the Globalization of Finance	Cally Jordan Giovanni Majnoni	October 2002	H. Issa 30154
WPS2920	Social Polarization, Political Institutions, and Country Creditworthiness	Philip Keefer Stephen Knack	October 2002	P. Sintim-Aboagye 37656
WPS2921	Initial Conditions and Incentives for Arab Economic Integration: Can the European Community's Success Be Emulated?	Bernard Hoekman Patrick Messerlin	October 2002	P. Flewitt 32724
WPS2922	"Does Globalization Hurt the Poor?"	Pierre-Richard Agénor	October 2002	M. Gosiengfiao 33363